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E'S DIRT IN THE FOREST

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THERE'S DIRT IN THE FOREST

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A Teachers' Guide prepared by the Western Education Development Group, the University of British Columbia, Vancouver

Introduction

Children love to scramble and explore! They are intrigued with experimenting and discovering things they've never seen before! The forest floor provides opportunities to explore, experiment and discover.

Soil covers much of the earth's land surface. The makeup of soil has a great influence on the types of plants that can be grown. Plants are basic to most food chains, therefore soil is essential to many of the earth's life forms.

This unit has been developed to help children learn about the components and characteristics of soil and to present an opportunity to study the forest soil environment in depth.

Field trips to the forest provide children with concrete experiences. The processes of keen observation, accurate description, comparison, and classification are developed. Hopefully, as they progress in their investigations, children will become more sensitive to the changes that take place in this part of their environment and will ask questions which will lead to further learning and appreciation.

Finding Soils in the Forest

On the first trip to study forest soils, pupils should be provided with plastic teaspoons. They should be given relatively unrestricted opportunity to explore different soils in the forest and the living things growing in them. Encourage them to compare teaspoons of soil from different locations and compare the plants that grow in each location. They will soon be investigating the different kinds of trees; young plants growing from stumps; moss on the bark of trees; fungi growing from the ground; the dead needles that often make up the top layer of forest soil; and sand and mud from the bottom of forest streams.

After initial exploration the children can be called together to discuss:

- What is soil?
- Are dirt and soil the same?
- What other words can you use to refer to soil?
- What words would you use to describe soil if you used your senses of touch, smell, sight, and hearing?
- Where can soil be found in the forest?
- Where else besides the forest can soils be found?
- How are soils different in these different locations?

Now you can send them off with a challenge to discover where there is soil other than on the ground.

Many of your pupils will say that soil is only on the ground. You can suggest they investigate the soil on stumps, rotting logs, stones or even in creeks and ponds. They can compare these soils with soil on the forest floor. What kinds of plants grow in each of the soils?

The moss growing from a huge rock may catch the children's attention. Have them lift a tiny portion of the moss and direct their attention to the material underneath. Can they find soil on the rock's surface where the moss is growing? Have them feel the rock. Is it dry or moist? Can they find the same mosses on the forest floor and on the bark of trees?

The children will also discover that there is soil on a decaying tree stump. Let them describe the soil that is on a stump and compare it with the soil from the bottom of a pond or in the crotch of a tree. There may even be young trees and mosses growing from it. Are these trees all of the same kind?

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A More Careful Look

This activity is designed to encourage children to observe more carefully and to describe what they see. First, each child should choose an area to study. Using a twig, each child reaches as far out as possible to scratch a circle on the ground around her. Using her five senses, the child then thinks of all the words which can be used to describe the ground within the circle and the things on it, both living and non-living. These describing words are listed on a piece of paper. Each child should try to describe at least two areas.

One child's observations

Circle No. 1:
wet, slimy, muddy, smelly.

Circle No. 2:
dry, powdery, brown and needley

Circle No. 3:
black, crumbly, soft.

Have the children try to define soil and as a whole group, create a class definition. Try not to make any amendments or additions. As the soil study continues, encourage children to add to this definition. A creative writing activity might grow from this, using Haiku — the Japanese poetry form.

Here are two examples:

Mud is in my shoe
Somewhere underneath it all
Earth is the planet.

or

Soft needley soil
Covered by woolly mosses
Trees explode skyward.

Digging Deeper

On a third trip to the forest, the class should be equipped with white paper, pencils, magnifying glasses, microscopes if possible, and plastic spoons.

The children should choose a location and spoon some soil on to a piece of white paper. Using the naked eye, they can observe and record what they see.

Children look upon soil as an inert material and are delighted to find insects, worms and other living things in their samples, along with bits of wood, leaves and gravel.

Next, encourage the children to observe the soil with a magnifying glass. Children become very excited as they find many more living things in their soil, and are better able to observe those which they have already found.

If you have microscopes available, they present an opportunity to study soil at still greater magnifications.

The observations can be recorded on a sheet of paper as follows:

Description of location: Circle under a tree, on a trampled path:

I saw with my naked eye:

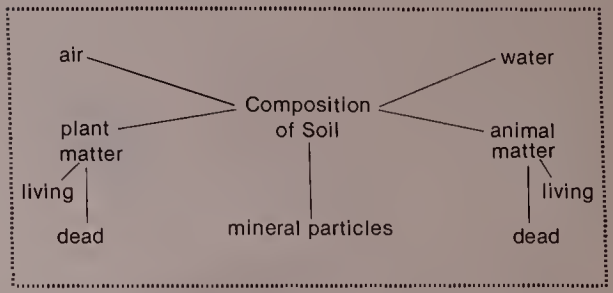
When I used a magnifying glass I saw:

When I used a microscope I saw:

After each child has completed one set of observations, call the class together for a discussion. Here are some possible questions:

- What things could you see in the soil with your naked eye?
- What parts of plants could you see?
- Could you find the plants from which the parts came?
- What animals could you see?
- What hard things could you see?
- What soft things could you see?
- What new things could you see with the magnifying glass? With the microscope?
- What worms could you find? Insects? Spiders?

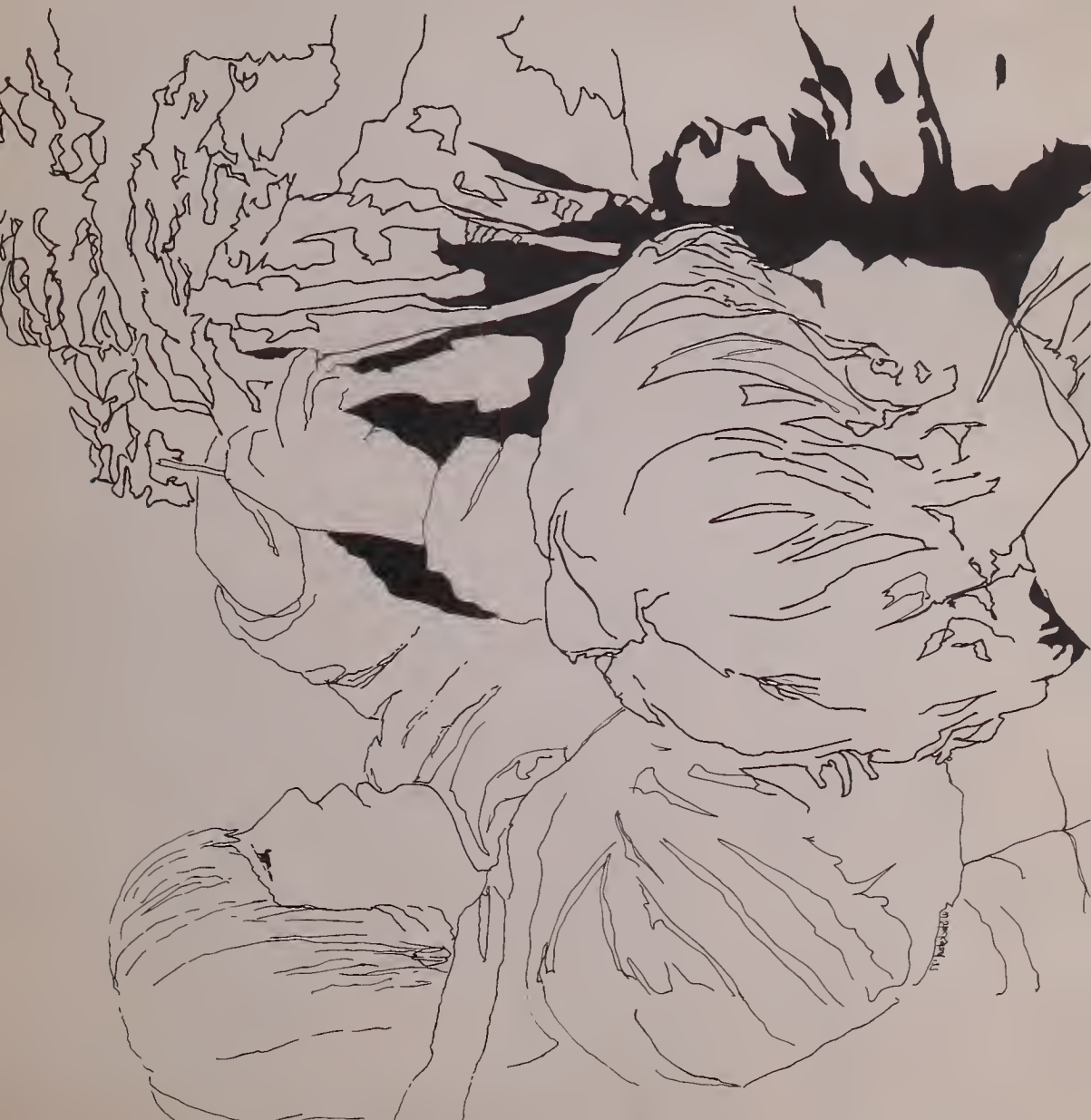
The following chart will help children focus on the various materials which make up soil.



In their early classifications, children use such characteristics as wet and dry, crumbly and sticky, color or smell, as the basis of their classifications. Occasionally a child will identify sandy or clay soils. These occasions offer you an opportunity to introduce soil classification according to standard textures.

Children find it easy to determine **sand** and **clay** soils, because of their previous experience with these materials in play. What child has not made sand castles or molded a clay figure. The soft black spongy soil typical of gardens is **loam.** If children have difficulty with the word "loam", why not just call it "garden soil". The litter of the forest floor, composed of bits of wood, bark and leaves, is relatively easily identified as organic "soil". Foresters refer to this as "duff".

As a result of their investigations with kinds of soils, children will be constructing an overall concept of soil. Teachers will find that a general discussion of this concept, on return to the classroom, will result in consolidation of ideas. Each child should be able to write his own definition of soil.



FOR YOUR INFORMATION

The following are the main types of soils:

Sand: Grains from rocks that are finer than gravel and coarser than clay, with very little animal or vegetable matter, if any. It feels gritty when rubbed between the fingers.

Clay: A fine grained material which is powdery when dry, plastic and slippery when wet. When compacted, it often forms a hard shiny ball.

Silt: Composed of grains finer than sand but coarser than clay. When it is compacted it forms a shape which is easily crumbled and is not shiny. Unlike sand, silt is smooth when rubbed between the fingers.

Loam: Mixture of sand, clay, dead vegetable matter and dead animal matter. Tends to compact but is spongy when wet. It is soft and powdery when dry.

Organic soils: Composed mainly of materials from living things that decay in time. These materials are dead twigs, leaves, branches and bark. It is usually black in color. The duff of the forest is organic soil in its early stage of development.

Very few soils are pure sand, clay, silt, or organic material. Loam is an example of a mixture which is very fertile. Other mixtures may be much less fertile. To be fertile, soils usually require a large amount of organic material to provide the nutrients required by plants.

Soil Formation and Structure

The presence of decomposing organic matter is a sign that soil making is underway. The original source of the soil's organic matter is plant and animal matter, the greater part being plant material. Dead grass, leaves, stems, and roots are the primary sources of a large proportion of the soil's organic matter.

Challenge the children to re-examine the surface of a small area on the forest floor for a few minutes, but emphasize that they should not disturb anything. Gather them again and discuss what they have discovered. Can they identify some of the leaves in their circle. Can they tell how much of the surface of their circle of soil was dead material? Live material?

Some children may have noticed more than others, but the discussion will help the less observant ones to see more things.

Focus the children's attention once more on the leaves of the forest floor, and ask them to start exploring. A variety of leaves will be found, some more dominant than others. The pupils often enjoy rearranging the fragments of leaves into whole leaves. In this way, patterns and similarities between leaves will often be noticed. They may observe that one kind is more advanced in decomposition than another. The children often attribute this to the thickness of the leaves or an earlier fall to the ground.

Ask a pupil to find three dried leaves which are in different stages of decomposition. She might choose one that has recently dropped from a tree, a second which is partly decomposed, and a third which is in an advanced state of decomposition. These leaves can be compared by asking the pupils how long ago the leaves fell from their trees.

Some possible questions that the teacher could ask are:

- Who made the holes in the leaf?
- In what ways are insects an aid in the formation of soil?
- Will these leaves become a permanent part of the soil?
- How long will it take for the leaves to become completely decayed into soil?
- Are fresh additions of organic matter to the soil seasonal? Which seasons are responsible?

The insects that live in the soil play a major role in decomposing the leaves which will eventually become a part of the soil. They eat the soft parts of the leaves and pass them through their bodies in the form of manure.

Have the students feel the soils around them with their fingers and classify them as sandy, silty, loamy or clay soils. Doing this focuses their thinking on a way of classifying soils which is usually new to them. Take them to a stream bank where the soil is exposed. Here they can usually find soils of several different textures.

The Story of a Forest

The forest soil is a record of the forest's life. The trees and other plants which grew in the forest and died have become part of the forest soil. Small bits of wood or bark in the soil may be all that is left of a forest giant which fell 150 years ago. It takes a long time to reduce a tree of five metres diameter to a long strip of black organic soil.

In this activity you can send the children off to find trees and stumps in various stages of decomposition.

Because some trees take so long to decay, their remnants carry with them evidence of the past. There is so much to see which can stimulate children to create exciting stories about the past.

The teacher can stimulate this kind of interpretive exercise by telling a story herself. She might begin by creating a story about a fire which, perhaps, occurred at the turn of the century but is represented now by a layer of burned debris in the soil or burnt areas on old half buried stumps. She may choose a cache of hazel nuts buried under a tree, long forgotten by a squirrel. After a story or two such as these, the teacher can challenge the pupils to find evidence of other stories from the soil.

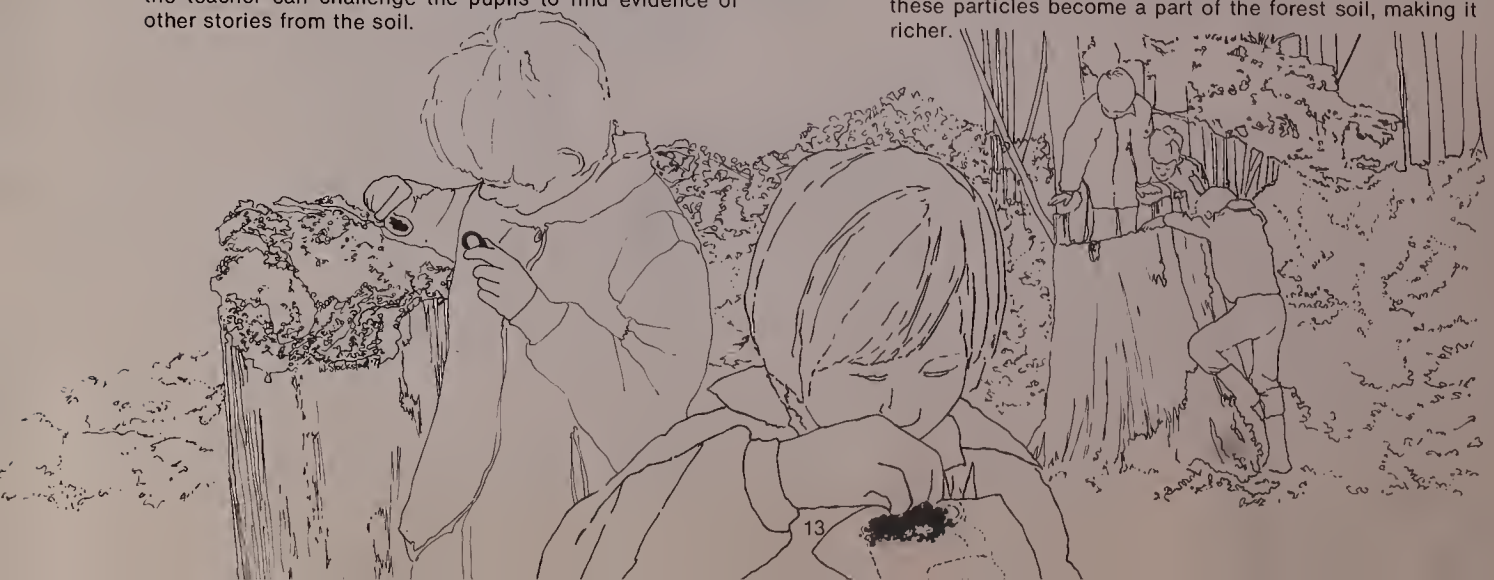
A Decaying Stump

A stump or a fallen tree which has undergone advanced decomposition and the soil around it make an appropriate study area for this activity. Sieves and magnifying lenses should be available. Ask the children to examine the soil around the stump. Some might sieve the soil while others might look at it with a magnifying glass. Give them freedom to feel it and talk about it after. Encourage them to describe the soil.

The following questions might be asked:

- What color is the material?
- Where did it come from?
- How did it become soft?
- Why is the stump crumbling into pieces?
- How old do you think the stump is?
- How long will it take for the whole stump to become a part of the soil?

The plants and animals that live on a fallen tree or stump change the wood more and more. The wood breaks up into tiny particles until it no longer looks like wood. Eventually, these particles become a part of the forest soil, making it richer.



Soil Erosion *

The day after continuous rain, the children can see where rain has washed the soil away. The children know that the rain is responsible for these "tracks", and if they are asked what happed to the soil, the immediate response is, "It was washed down, some of it." Hence, the children have begun to understand that forest soil can be eroded and rainwater is one of the agents of erosion.

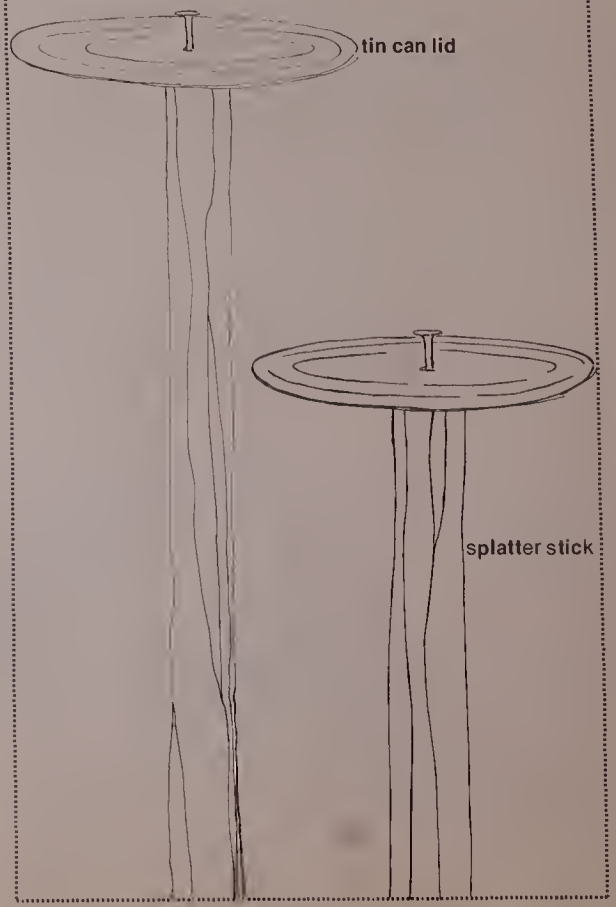
Generally speaking, the forest floor is covered by a fairly thick layer of decaying leaves, needles, and other debris. This layer forms an effective defense against erosion of forest soils, especially where the rain is intercepted by a thick canopy of branches. Thus, serious erosion rarely occurs in a dense forest. When the forest canopy is removed by logging and the protective layer of leaves and debris on the soil is disrupted by the churning effect of heavy machinery, erosion of almost incredible proportions often occurs.

A simple experiment can be performed on a sloping site by removing a square metre of the duff layer down to recognizable soil. If the site is observed after a rain storm the effects of erosion will be immediately seen in the form of small channels and globs of spattered mud. The experiment can be improved by installing splatter stakes.

The splatter stakes can be used to show the effects of splatter. Their bases are usually filthy with mud after a heavy downpour. In addition, if ground level is marked on the sticks with a pencil, the depth of soil which has been washed away can be measured. Depending on the slope, soil conditions and amount of rainfall, a centimetre or two of soil may well be gone in a short space of time.

*Other erosion experiments are described in the unit *Grounds for Erosion,* Western Education Development Group. 1973.

Splatter stakes are wooden sticks about 45 cm long which are pushed into the ground about 15 cm. They should be light in color so splattered mud can be easily observed. We find freshly split wood is very satisfactory. A tin can lid nailed to the top of the stake forms an umbrella to prevent the splatters from being washed off.



Water Absorption in Forest Soils

Water may enter the soil of the forest through rainfall, surface run-off or from underground sources. The amount of water in the soil can be affected by:

1. The amount and frequency of rainfall.
2. The amount of snow.
3. The humidity and temperature of the air.
4. The amount of forest cover.
5. The slope of the land.
6. The type of soil cover.
7. Nearness to ground and surface water (streams and ponds).

Obviously, the water relations of forest soils are very complicated, but forest soils usually have quite stable moisture levels. Forest soils which have become very dry take a long time to become moist again. A very heavy rainfall after a period of drought may not make any appreciable difference to the fire hazard because the moisture may only penetrate half a centimetre into the soil and most will evaporate very quickly. On the other hand, it takes a very prolonged hot spell to dry out moist forest soil.

A soil moisture survey is best conducted over a series of weeks in the spring, beginning about the middle of May, when most forest soils are wet. If an area close to the school is chosen, a number of trips can be made to this site to determine moisture changes.

We find that elementary school children can effectively gauge moisture content by feeling the soil (see accompanying chart). It is important, however, that the site which is selected can be found again, so that proper comparisons can be made. It is recommended that the teacher choose an obvious natural landmark such as a large tree or stump, and have the children map the area showing the landmark and the soil moisture sampling site as the accompanying diagram illustrates.

Determining soil moisture:

Dry — falls through your fingers.

Slightly moist — appears damp but doesn't stick to your fingers.

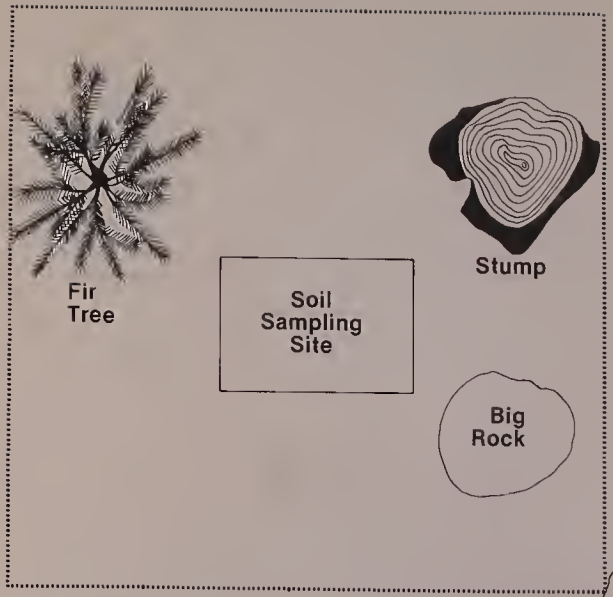
Moist — sticks in a clump when squeezed together.

Very moist — water appears when the soil is squeezed.

Wet — water drips from squeezed soil.

Soil Water Absorption Results

Date	Surface	5 cm Down
May 12	Wet	Damp
May 20	Damp	Damp
May 30	Wet	Slightly Damp
June 10	Dry	Dry
June 16	Damp	Dry


Fir
Tree
Soil
Sampling
Site
Stump
Big
Rock

Finding the Amount of Moisture in the Soil
(A classroom activity)

The amount of moisture in forest soil is quite easy to determine. Children have no difficulty distinguishing between moist and dry soil, but they are always surprised to find out how little soil weighs when it is dry, especially the top soil from the forest. It would be best to be able to show children the actual water which has been removed from soil. Unfortunately, no simple technique has been developed which extracts liquid water. We must depend on evaporation.

To carry out this experiment, two identical soil containers will be required (e.g. 4 litre plastic pickle jars), one of which can be sealed air tight. You also require a scale. A common bathroom scale, in kilograms, will do the job accurately enough. Of course, you will also need a shovel, a source of moist forest soil, and a source of relatively dry forest soil for comparison purposes.

Setting up the activity:

While you are on the field trip for the previous activity, select the most moist soil you find to use in this activity. In selecting the soil, be careful to choose a soil which feels moist, but does not actually drip with water. With a shovel, collect two approximately equal amounts. For best results, fill the two 4-litre jars to the top. Each of the jars should be quite heavy with soil, and can be a burden to carry back to the school. Once back in the classroom, weigh the two jars of soil on the bathroom scale and equalize the weight by transferring soil from one to the other until they weigh the same number of kilograms. If you selected the soil from the same place, the full jars should be very close to equal when you weigh them. Record the weight.

The experiment:

Set the two jars in a warm place in the classroom so that evaporation will take place fairly rapidly. Be sure to cap one of the jars very tightly so that no moisture will escape. Then leave the two jars for approximately one month. Weigh them each day, recording the results in two graphs; one to show the stability of moisture content in a closed container, the other to show the drop of weight due to evaporation of water from the soil in the uncapped jar.

Some questions which can be asked:

1. How has the soil changed in each of the two containers?
   a) What color changes have occured since the experiment began?
   b) How has the odor changed in each of the two jars?
   c) How does the soil feel compared to the beginning of the experiment?
   d) Has anything grown in the jars?
   e) Has there been any change in the levels of the soil in the jars?
   f) Has there been a change in weight?

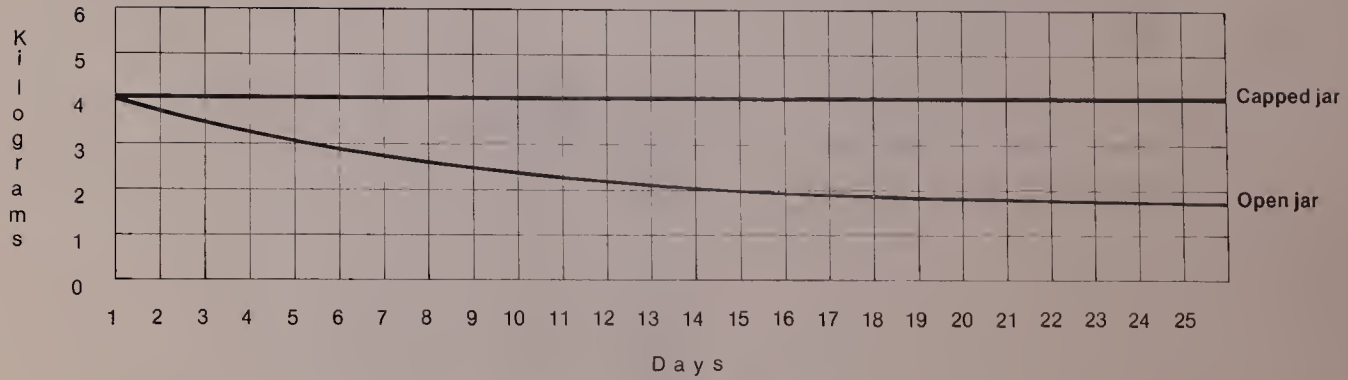
2. What possible explanations exist for the changes which occured?

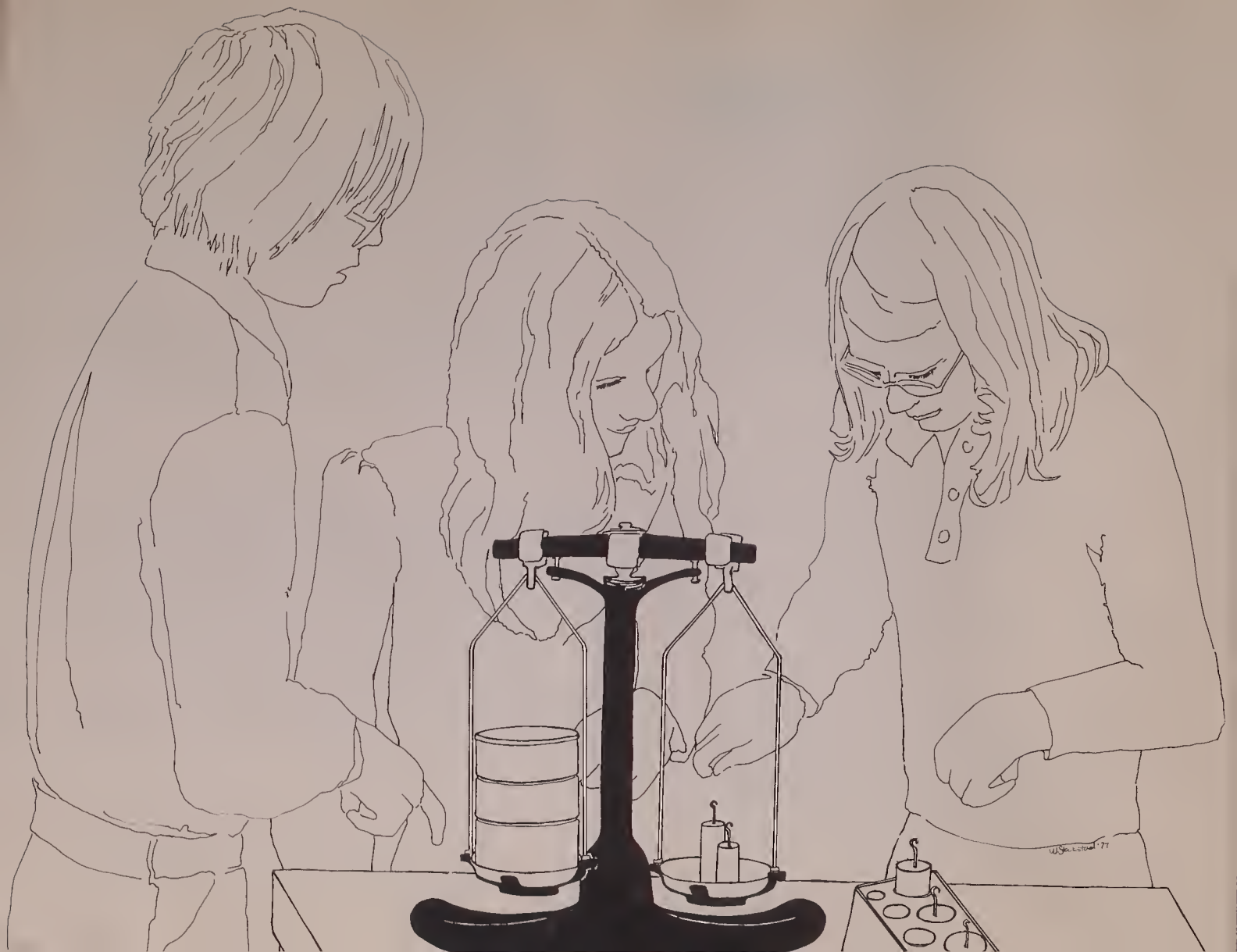
This question will stimulate many explanations for the differences between the two jars. Though there has been only one factor changed, a lid tightly screwed on the one jar, many effects will be noted. The lively exchange between pupils will give the teacher many opportunities to suggest new experiments.

Hopefully, some of the pupils will realize that the key difference between the two jars is the presence or absence of water.

A good addition to the experiment is a third jar. This jar is kept open, and every third or fourth day, water is added to bring it up to its original weight. Keep a record of the amount of water added. Now you have two experiments going. In one, you are testing the effect of tightly enclosing the moist soil in comparison with an open jar of the same moist soil. In the other, you are testing the effect of adding water to return the open jar of soil to its original weight.

Children will suggest many other variations to this interesting experiment.


Kilograms
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Days
Capped jar
Open jar



How Much Water can Forest Soil Hold?
(A classroom activity)

The last two activities will have convinced children that there is water in soil. They have difficulty, however, with the concept that soil actually holds water in the sense that a sponge holds water. In spite of what they have seen they often believe that if you let the soil stand long enough the soil on top will be dry and there will be a small pool of water at the bottom.

To do this experiment you will require two coffee cans with small holes punched in the bottom, lids for the cans, some dry forest soil, a scale to weigh the soil, a large bucket and some water.

Setting up the activity:

Fill each of the cans with dry soil so that they are about three quarters full. Put the covers on the cans and weigh each carefully, recording the weights. Pour water into the bucket so it is about 3 cm deep.

Doing the experiment:

Take one of the coffee cans and place it in the bucket so that water enters through the small holes punched in its bottom. Leave it in the water for about twenty minutes. Then take it out of the water and let it drain overnight. Weigh both the cans the next day of class and note weight differences. Weigh them again during the following three or four classes. Encourage the pupils to feel the soil to discover the difference in moisture content.

Many children are surprised to find that water can go up into the can and stay in the soil for long periods of time. This experiment is often carried out in such a way that the water is poured on the soil — thus tacitly confirming children's notions that water goes down into soil and keeps on going, though slowly. The key to the experiment is to ensure that the holes on the bottom remain open.

Comparison of the moistened soil from the experiment with moist soil from the forest will help children develop the concept of soil water retention.

Knowing the volume of the can and the amount of water in the soil (from their obtained weights) children can calculate the amount of water in a forest soil area 100 m^2 (100 $\times 100 \times 100$ cm^2). If you consider the top 12 cm of the soil to be similarly moist, you can calculate the amount of water in this area 100 m^2 and 12 cm deep as follows:

In our experiment 120 g of water were soaked up by 1200 cc of soil

$\therefore$ 1 g of water was soaked up by 10 cc of soil

$\therefore$ the amount of water soaked up by 100 m^2

$$= \frac{100 \times 100 \times 100 \times 12}{10}$$

= 12,000,000 g

= 12,000 kg of water:

Remember one litre of water weighs a kilogram so there are 12,000 litres of water in the top 12 cm of our area of 100 m^2.

That's a lot of water!

W.J. Stockford '77

How Trees Affect the Water Content of the Soil

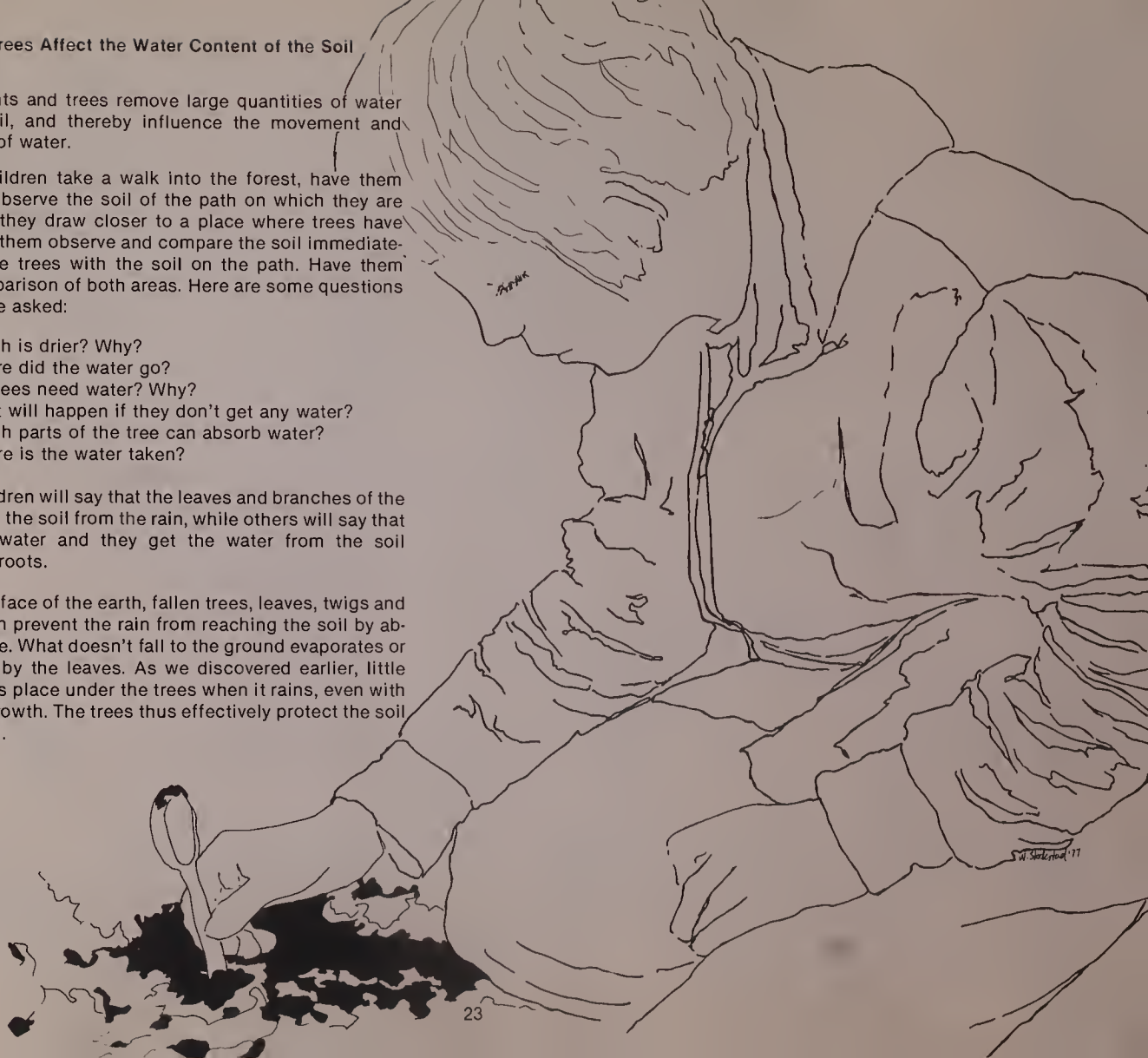
Small plants and trees remove large quantities of water from the soil, and thereby influence the movement and distribution of water.

As the children take a walk into the forest, have them notice and observe the soil of the path on which they are walking. As they draw closer to a place where trees have grown, have them observe and compare the soil immediately around the trees with the soil on the path. Have them make a comparison of both areas. Here are some questions which can be asked:

- Which is drier? Why?
- Where did the water go?
- Do trees need water? Why?
- What will happen if they don't get any water?
- Which parts of the tree can absorb water?
- Where is the water taken?

Some children will say that the leaves and branches of the trees protect the soil from the rain, while others will say that trees need water and they get the water from the soil through the roots.

On the surface of the earth, fallen trees, leaves, twigs and branches can prevent the rain from reaching the soil by absorbing some. What doesn't fall to the ground evaporates or is absorbed by the leaves. As we discovered earlier, little erosion takes place under the trees when it rains, even with little plant growth. The trees thus effectively protect the soil from erosion.



It has been calculated that, including the microscopic animals, there can be more animals in a square metre of soil than there are people in the world.

The larger animals of the soil are chiefly rodents, insects, millipedes, sawbugs, mites, slugs, snails, centipedes, spiders and earthworms. The burrowing habits of these animals, particularly the earthworm, result in the chewing up and transfer of very considerable amounts of soil. Earthworms feed on leaves and other organic materials in the soil and transfer chewed and digested soil and leaf bits to the surface as they burrow, thereby distributing organic materials through the soil. Not only do these animals decompose and mix organic matter in soils, but also their burrows serve to aerate anddrain the soil. Some children will say that earthworms turn up the soil and make it finer while others will assert that the creatures eat the soil. Both are correct.

Finding evidence of the work of insects is more difficult. Look around stumps and fallen logs. The children will find evidence of insect activity. Their droppings are bits of powdered wood or compacted pellets of leaf materials. These materials, along with dead insect bodies, also add to the soil content eventually.

As the children carefully peel back layers of leaves on the ground, a living world of scurrying insects emerges. They can capture some of these insects. Equip the children with a clipboard, pencil attached to the clip, a piece of paper, and a data sheet. By sliding the white paper under the insect, they would have a perfect surface on which to observe and examine the creatures. Perhaps most of the insects are unknown to the children, but the ability to recognize species is unimportant for this particular activity. Those who are really interested can try to identify them. You might want to use the accompanying data sheet.

Children enjoy using a sieve to search for insects. They can sieve a teaspoon or two of loam or humus soil and if their eyes are really keen, find a number of insects on the screen. If they do not find any insects, they should be encouraged to try in another area. To facilitate sieving, this activity can be done when the soil is dry. If the soil is wet, the children will have to stir it around, often unintentionally killing the insects, and making it almost impossible to recognize them.

INSECTS IN THE FOREST SOILS

1. Name the insect if you can._____

2. How big or how long is the insect's body? Circle the best length.

3. Sketch it quickly showing the different sections of the body.

4. How fast can it move?_____

5. How fast was it moving when you first saw it?_____

6. Where did you first see it?_____

7. What is the color of the insect?_____

8. What distinguishing features such as wings or antennae does the insect have?

A Study of the Layers of the Soil

As you dig into the soil of the forest, a series of layers becomes evident. It isn't necessary to dig to find these layers for your class. They will already have been noticed on the steep bare banks of many forest streams. A description of these layers makes a soil profile.

To study soil layers exposed on a stream bank or in a road cut, have the students examine teaspoons of soil from different layers. They should feel each teaspoon to identify the texture. (See p. 9.) Screen it to identify and size the particles.

The pupils often make up their own names for the layers, choosing color or texture. Encourage the students to tell why they have given a particular name to a layer. Here are some questions you can ask:

- Which layer is thickest?
- Which is moistest?
- Which layer is driest?
- Which layer is hardest?
- Which layer is softest?
- Which layers have living things in them?

SOIL PROFILE DESCRIPTION

Layer _____

Depth _____

Color _____

Texture _____

Composition _____

FOR YOUR INFORMATION

The layers of the soil from the surface down are:

1. **Organic layer: This layer is divided into two parts:**

   a) **Forest litter or duff: This is the topmost layer and is composed of dead leaves and twigs or even roots which have not undergone much decomposition. They are fresh additions to the soil.**

   b) **Humus soil: Found immediately below the forest litter, it is formed from the decomposition of dead leaves, twigs, roots and branches.**

2. **'A' Horizon: This layer contains organic matter that has been subjected to extreme weathering. It is usually light in color, often ash-grey or white. It is commonly of a coarser texture than the underlying layer. It may not be found in all soil profiles.**

3. **'B' Horizon: This layer is also known as the accumulative horizon. It is found immediately below the 'A' horizon and contains minerals and fine organic materials. The color tends to be brown or red due to the presence of iron.**

4. **'C' Horizon: This layer contains the unweathered rocks, usually the material from which the soil minerals have come.**

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CREDITS

This unit is primarily an outgrowth of the work of Victoria Tercias, with many ideas and suggestions by Arlene Offer, Susan Infanti and Joan Fefferman. The present version has been adapted by Kip Anastasiou based on the comments of many teachers who have tried the unit with their classes.

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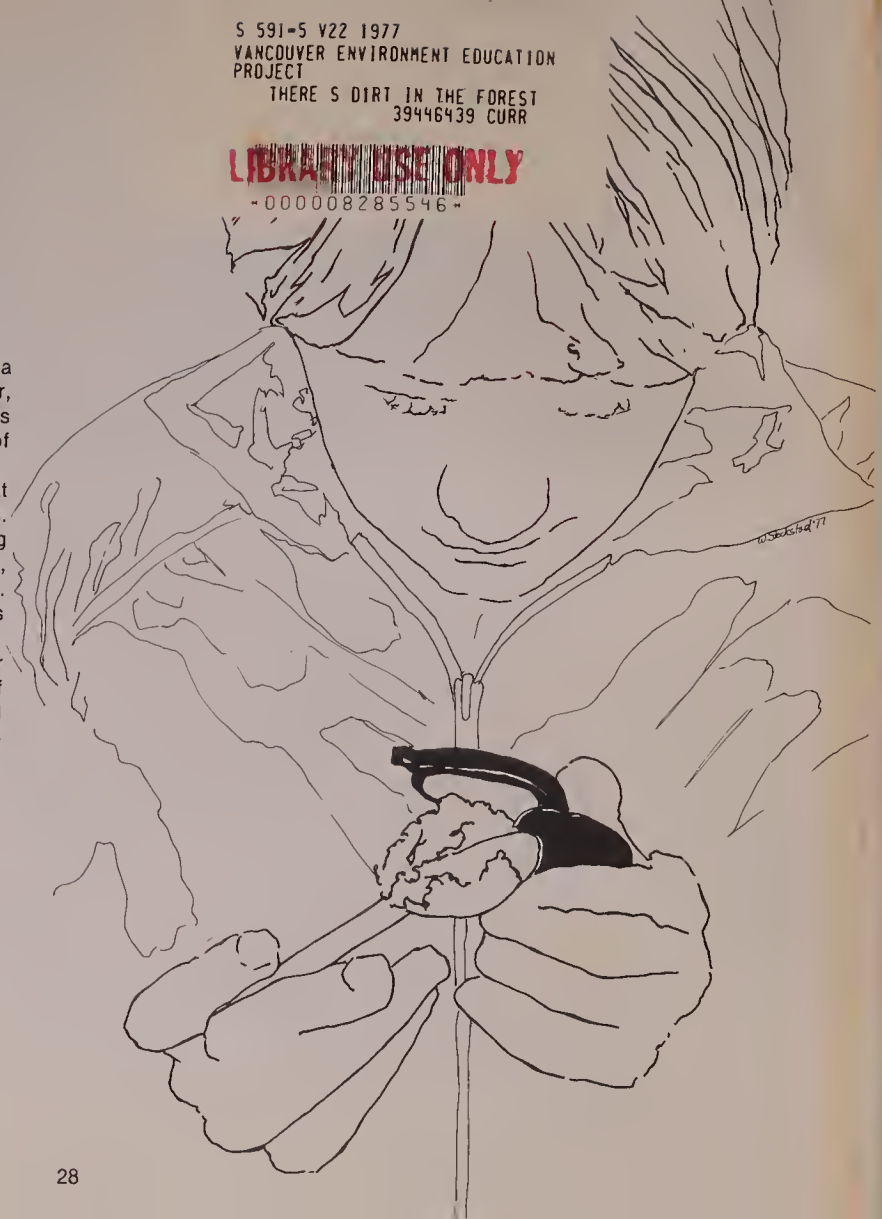

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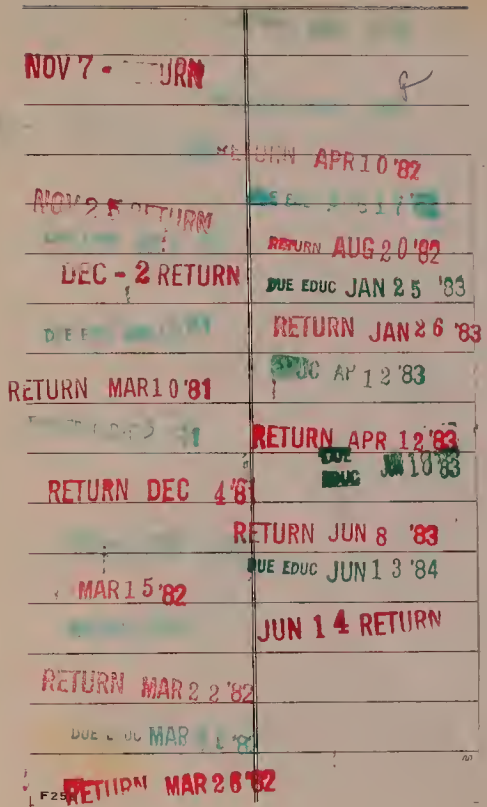
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